THE OVARIAN STRUCTURES OF THE VIVIPAROUS BLIND FISHES, LUCIFUGA AND STYGICOLA.[1]

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I. Introductory.

During the spring of 1902, Dr. C. H. Eigenmann collected a number of specimens of blind fishes in the caves of western Cuba, within a radius of 130 kilometers of Havana. The fishes belong to the two distinct but closely related genera, *Lucifuga* and *Stygicola*. It has been my good fortune to have the opportunity of studying the reproductive organs — more particularly, the ovarian structures — of these blind fishes, with special reference to their method of reproduction. It was discovered upon examination of the specimens that they are viviparous,[2] a fact long known in regard to some of their deep-sea relatives. Owing to the lateness of the season when they were collected, unfortunately but one female was pregnant. This one measured only 65 mm. in length and contained four fœtuses — borrowing a term to designate the post-larval stages of the young until birth — 18–20 mm. long. These fœtuses were in an advanced stage of development, very probably being within a few days, or possibly hours, of birth, since a number of young only 25 mm. long were caught in the water. No other prenatal specimens having been secured, it has been impossible to study the early stages of development. My attention has been particularly directed to the ovarian structures of the mature females secured. A few of the young specimens, evidently taken not long after birth, were also examined.

I wish here to express my deep sense of obligation to Dr. C. H. Eigenmann for his assistance and criticism in the preparation of this paper.

[1] Contributions from the Zoölogical Laboratory of Indiana University, No. 58.

[2] Eigenmann, '03, p. 236, pl. 21.

II. Systematic Position of Lucifuga and Stygicola.

Poey[1] ('60) described these fishes in 1860, giving them the generic name of *Lucifuga*, recognizing them, however, as two species, *dentatus* and *subterraneus*. Later Gill, '63, separated *dentatus* from the other and created the genus *Stygicola* for it. The two genera are different in that *Stygicola* has teeth on the palatines, where *Lucifuga* has none, and the teeth in the jaws of the former are larger than those of the latter. There is also a very noticeable difference in the depth of the head at the nape, in adult individuals. The two species or genera are however so nearly alike that it is only after a prolonged comparison that the above technical differences were made out.

The several species of blind cave fishes, found in Indiana, Illinois, Kentucky and Missouri, are not related to the Cuban species. The latter are descended from marine forms which have worked their way through underground channels into the Cuban caves. Related genera that still live in the ocean about Cuba are *Brotula*[2] and *Ogilbia*[3] in moderate depths and *Bassozetus*[4] and *Aphyonus*[5] in deep water.

All of these genera belong to the family Brotulidæ, a deep-sea group comprising about forty-five genera and one hundred species, living mostly in the tropical seas of both hemispheres. The two genera under consideration in this paper are the only ones found in fresh water. Jordan and Evermann (*op. cit.*, Pt. III., p. 2498) observe very properly that "these fishes are closely related to the Zoarcidæ. In spite of various external resemblances to the Gadidæ their affinities are rather with the blennioid forms than with the latter."

III. Historical.

Numerous contributions to our knowledge of viviparity in fishes have been made from the time of Cuvier to the present.

[1] *Lucifuga*, Poey, "Memorias," II., 95, 1860 (*subterraneus*); *Lucifuga subterraneus*, Poey, "Memorias," II., 96, 1860; *Lucifuga dentatus*, Poey, "Memorias," II., 102, 1860; *Stygicola dentata*, Gill, *Proc. Ac. Nat. Sci. Phil.*, 252, 1863.

[2] *Brotula* (*vid.* Bull. 47, U. S. Nat. Mus., Jordan & Evermann, "Fishes of North America," Pt. III., p. 2500).

[3] *Ogilbia* (*vid. idem*, Pt. III., pp. 2502, 2503).

[4] *Bassozetus*, Gill (*vid. idem*, Pt. III., p. 2507).

[5] *Aphyonus*, Günther (*vid. idem*, Pt. III., p. 2525).

Among the most important ones are the following, most of which I have consulted in connection with my own investigation:

Cuvier and Valenciennes, in their "Histoire Naturelle des Poissons," I., Paris, 1828, have a short general account of viviparity in fishes, and mention is made of it frequently throughout their work in the description of such fishes as bring forth living young. Much of their work has been superseded by the more accurate observations of later investigators.

Rathké, in 1833, published his "Bildungs- und Entwickelungsgeschichte des Blennius viviparus odes des Schleimfisches." This was long the best paper on the subject.

In 1844 (*Ann. des Sc. Nat.*, t. I., 3d series, p. 313) Duvernoy published a paper on *Pœcilia surinamensis*, which is frequently referred to by more recent writers, but which I have not had the opportunity of consulting.

In 1846, Cuvier and Valenciennes described the genus *Anableps*, one species of which, *A. gronovii*, formed the subject matter of an important paper by Jeffries Wyman, in the *Boston Journal of Natural History*, Vol. VI., No. IV., p. 432, 1857. I shall refer to this article more at length below.

In 1853, Louis Agassiz (*Am. Jour. of Science*, XVI., 2d series, Nov., 1853) described a new family of fishes from California — the Embiotocidæ, which embraces the genus *Cymatogaster*. The only species of this genus, *C. aggregatus*, was studied in detail by Dr. Eigenmann, and the results published in the *Bulletin of the U. S. Fish Commission*, Vol. 12, p. 401, 1892 (1894).

Another very important paper, "On the Development of Viviparous Osseous Fishes and the Atlantic Salmon," by John A. Ryder (*Proc. U. S. Nat. Mus.*, 1885, pp. 128–162, Pls. VI.–XII.) will be noticed frequently below.

In 1887, Dr. Franz Stuhlmann made a detailed study of *Zoarces viviparus*, Cuv., the results of which he published under the title, "Zur Kenntnis des Ovariums der Aalmutter (*Zoarces viviparus*, Cuv.)." Frequent references to this volume will be made below.

IV. Viviparity in General.

Cuvier and Valenciennes (*loc. cit.*) give a general account of viviparity in fishes so far as known at that time; but since their

statements are now either matters of common knowledge or else not in accordance with the facts as revealed by later investigations, I shall not speak of their work further.

Wyman (*op. cit.*) classifies viviparous fishes into two groups "according to the position occupied by the embryo during the period of growth. In the first group may be arranged those fishes in which *the ovum leaves the ovary in an undeveloped state, and in which the process of eolution* (*sic*) *is not commenced until it reaches the lower portion of the oviduct.* The fishes which this group comprises are nearly all, if not all, Plagiostomes. The best known are *Spinax*, *Carcharias*, *Mustellus*, *Galeus*, and *Torpedo*. . . . II. In the second group those fishes are comprised in which *the gestation is wholly or in part ovarian*, the last stages only of the process usually occurring in the oviduct. Among the genera included in this division are *Silurus*, *Blennius*, *Anableps*, *Pœcilia* and *Embiotoca*. In all of these genera impregnation takes place in the ovary, and, as seems probable, while the ovum is still invested with its original envelopes."

Wyman found that each of the fœtuses in *A. gronovii* is enveloped in a separate sac of vascular tissue, much too large for the fœtus enclosed, the extra space being filled up with an albuminous fluid. He seems to regard these fœtal sacs simply as extensions of those within which the ova were suspended.

Eigenmann, considering only teleosts, found two types of viviparity (*op. cit.*, p. 404); he says:

"At least two types of viviparity may be distinguished in fishes; first, those in which the yolk furnishes all the intra-ovarian food; and second, those in which the greater part of the food is furnished by the ovary.

"In the first type the number of young is not less than in related oviparous forms, while the number of young in the second is always greatly reduced. . . . The size and development of the young in this class (type I.) of fishes at the time of birth is of course much less than in the second class of viviparous fishes."

As will be seen, *Lucifuga* and *Stygicola* belong to the second type of both Wyman and Eigenmann. The number of young is small and they are born in quite a mature condition.

V. Gross Anatomy.

For the sake of clearness the following terms will be used in the sense here given:

Oviduct — the single duct leading from the ovary to the urogenital pore. Ovisac — the forward continuation of the oviduct which covers the ovary. Ovary — the structure containing the eggs. Stroma — the supporting tissues of the ovary itself.

The term ovary is also used in a general way to include the ovisac and the ovarian structures proper. The context in every case will determine what is meant.

In *Lucifuga* and *Stygicola* the ovary is enclosed between two layers of peritoneum above the posterior portion of the alimentary canal. It may extend so far forward as to lie in part even beside the stomach.

The ovary has a bilateral arrangement. Externally it is a Y-shaped, bifurcated, subcylindrical organ, whose greatest diameter is immediately posterior to the point at which the division begins (Fig. 1). The two horns lie on the right and left sides respectively and may enclose between them the posterior portion of the stomach. Interiorly the stem of the Y is divided by a median partition with which the ovarian structures proper are associated and which extends to near the oviduct, though here only the portion attached to the ventral wall is found (Fig. 2). From the tips of the ovarian horns slender though comparatively strong threads of connective tissue, inclosing blood vessels, run forward and fasten to the peritoneal walls, thus very securely holding the ovary in position. Dorsally, the ovary is attached to the peritoneal lining of the body cavity by the mesovarium; ventrally, there is a corresponding attachment, the mesorectum. The oviduct, which opens externally at the urogenital pore, increases gradually in size as it approaches the ovary and finally merges into the ovisac, or outer wall of the ovary.

A somewhat immature specimen shows finely those structures connected with the support of the ovary. In it one sees that each horn is supported by its own fold or lamina of peritoneum; that these two laminæ become united at or near the point of division of the horns and are continued posteriorly as a single though thicker mesovarium supporting the body of the ovary

and the oviduct. Below there is no sign of a mesorectum in the region of the ovarian horns, except for a short distance near the base of one of them, but posterior to them there is such a membrane, inclosing several blood vessels, and itself somewhat thicker than the mesovarium above. It is also clear from an examination of this ovary that, as will be noted more particularly below, the egg-bearing tissue, the ovary proper, forms a thick median partition in the ovisac.

The external appearance of the ovary agrees very closely with Eigenmann's description (*op. cit.*, p. 418) of that of *Cymatogaster*:

"The ovary is a spindle-shaped bag, divided anteriorly into two arms which indicate the bilateral origin of the present structure. One of these arms, the left, is usually smaller than the other. . . . The ovaries of the two sides have evidently been united from behind forward, so that externally only the two anterior horns show the bilateral structure, and one of these horns seems to be in process of phylogenetic resorption."

While there is frequently a difference in the size of the two horns in *Lucifuga* and *Stygicola*, there is no uniformity in this matter. There seems to be no evidence that the right or left portion of the ovary is "in process of phylogenetic resorption." Ryder found that in *Gambusia patruelis* "the ovary is a simple unpaired organ, the greater part of which lies on the right side of the body-cavity below the air bladder. . . ."

The size of the ovary varies, of course, with the age and size of the female, as well as with the state of development of the ova or embryos contained in it. One female of the genus *Lucifuga*, which had a length of 65 mm. and which contained four fœtuses nearly ready to be born, had an ovary with a length — measuring to the extremity of the longer horn — of 16 mm., and a diameter of 8 by 9 mm. As the fœtuses were 18 to 20 mm. long, it was not surprising to find that their tails were bent over. Another female of the same genus, 83 mm. long, had evidently given birth to young only a short time before her capture and had an ovary 12 mm. in length.

The point of division into the two horns is usually about five twelfths the distance from the anterior tip of the ovary to its posterior end. As already stated, the two horns rarely show equal

PLATE I

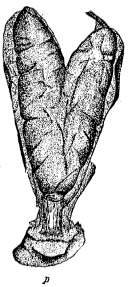


Fig 1

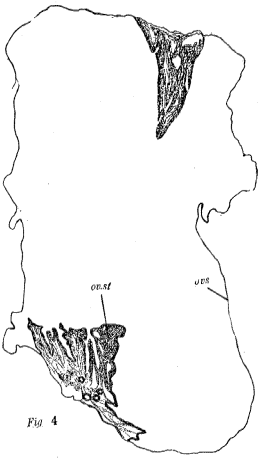
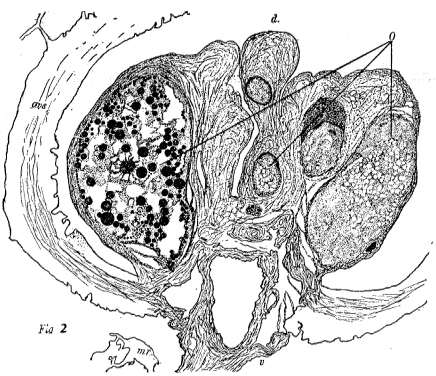


Fig 4



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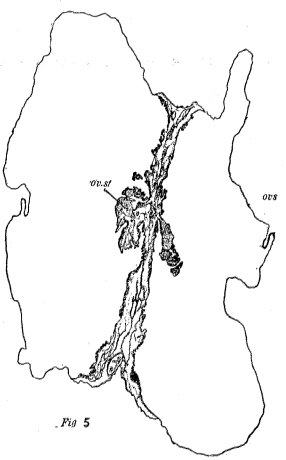

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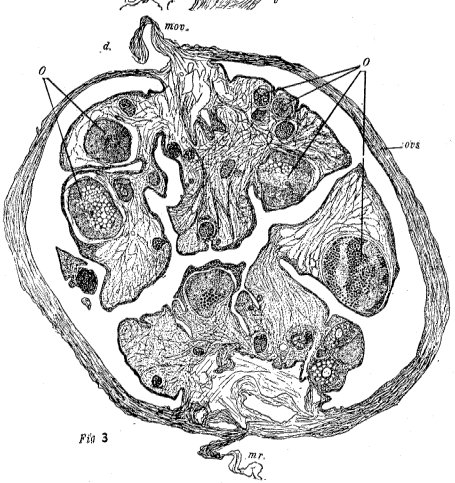

Fig 3

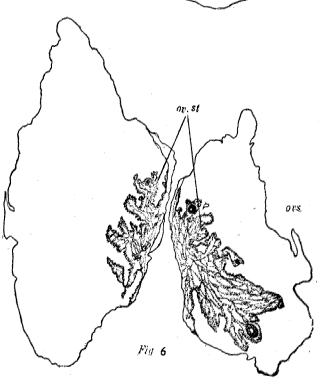

Fig 6

development, there being always a more or less marked difference in size.

Between the ovisac and the ovary proper there is a lumen of varying size. When there are larvæ present, the ovisac and the oviduct are extremely thin and so stretched, especially near the close of gestation, that their cellular structure cannot be made out with any satisfaction (Fig. 5). Shortly after birth of the young they contract and assume the form and appearance found in the ovaries of mature but non-pregnant females (Fig. 3). The wall of the ovisac is then quite thick, and the lumen very small. The histological structure of the ovisac will be described below.

In non-pregnant ovaries, the stroma is a mass, which, internally, has a bilateral arrangement and occupies most of the space within the ovisac (Figs. 2, 3). It is, in general shape, fusiform with its largest diameter just posterior to the division of the ovisac into the two horns down both of which it is continued along their median surfaces, forming the prongs of a Y. In the middle of the ovary the stroma forms a median partition; somewhat posteriorly this partition is cut across (Fig. 3), and still further back only the ventral part remains (Fig. 2). It has many lobes which are usually somewhat pointed and comparatively large and distinct, the indentations sometimes leaving merely a "neck" of tissue to support them. The whole stroma at this time is fully distended by the large amount of lymph contained in the sinuses described below. Where the ova are well advanced they can be seen by the unaided eye in the form of opaque dots. When the ova are surrounded by follicles, they lie some distance below the surface of the stroma and there is a tubular indentation of the epithelial covering of the latter down to the follicle (Fig. 7, *D*). In a circular space over the egg the epithelium is apparently continuous with the follicle. It is only on very close inspection that the independence of the follicle can be made out. It is then found to be of only a single cell in thickness beneath the epithelial indentation. A similar position of the epithelium was noted by Stuhlmann over the ova in the ovary of *Zoarces* and was called "Delle" by him.

The pregnant ovary is quite different in appearance from that of a non-pregnant female. A cross-section of the former shows

it to be an almost bilaterally symmetrical organ, but without any folds or pockets in which the embryos are contained as is the case in *Cymatogaster*[1] and numerous other species of Embiotocidæ. During the intra-ovarian development of the embryos, or rather the development of the fœtuses within the oviduct of *Lucifuga*, the ovarian structure proper or stroma which forms the thick median partition in non-pregnant ovaries, becomes gradually reduced and compressed into a narrow wall (Fig. 5). The stroma is much thickened both dorsally and ventrally near the oviduct (Fig. 4), where the partition is incomplete, but anteriorly its greatest thickness is near the median plane (Fig. 5). The arrangement of the stroma in each horn of the ovary is as in non-pregnant ovaries (Fig. 6, *ov.st.*).

The single oviduct runs from the caudal end of the ovary proper to open at the urogenital pore. In pregnant females it is widely distended for some distance when the fœtuses are well advanced, but in the non-pregnant females it is a rather cylindrical, thick-walled, muscular tube with numerous folds or laminæ on its inner surface, covered with a layer of columnar epithelial cells, 12 μ in depth. It is not materially different, except as to dimensions, from the ovisac described above. Stuhlmann[2] similarly found the oviduct of *Zoarces* to be a tube composed of the same cell-layers as the ovary, with the exception of the "germinal" and follicular epithelia.

VI. Histological Part.

I. The Walls of the Ovary or Ovisac.

The following system will be used to facilitate cross references to the descriptions of the various ovaries. Each ovary will be referred to by a letter, *A*, *B*, *C*, etc., the meanings of which are as follows:

A represents a female of the genus *Stygicola* with a length of 95 mm.

B represents a female of the same genus, but with a length of 128 mm.

C represents a female of the genus *Lucifuga*, length 87 mm.

[1] Eigenmann, *op. cit.*, p. 418.

[2] *Op. cit.*, p. 10.

D and *E* represent females of the same genus with a length of 83 and 65 mm. respectively. *E* was pregnant; the others were non-pregnant.

An examination of the ovisac and oviduct reveals quite a range of variation, depending in the main upon the condition of pregnancy or upon the length of time that had elapsed since the close of that period.

In the ovary of *D*, which had not been pregnant at all, or at least for so long a time that the ovarian structures had regained their normal form, the wall of the oviduct and the ovisac is from 100 to 150 μ in thickness at different places. Structurally, the ovisac consists of at least four cell-layers. The outer, a sinuated, peritoneal layer, immediatly beneath which there is a thicker layer of longitudinal muscle fibers; below this there is another somewhat thicker transverse band of muscle fibers; on the inner surface there is an epithelial layer *containing numerous capillaries*. This will be described in detail below. The nuclei of the longitudinal band are rod-like in appearance; the nuclei of the second muscle layer appear more nearly round, being evidently the cross-sections of nuclei of the same form as those in the longitudinal band. The innermost layer of epithelial cells has nuclei oval or round in shape, while the peritoneal layer shows few nuclei, but those which do appear are rod-shaped in section. Quite numerous capillaries are found between the cells of these several layers and in some places there are large blood vessels.

In the ovary *A* from a female which had evidently given birth to young but a short time previous to her capture, the ovisac measures only 15 to 20 μ in thickness. Structurally it consists of four or five thin cell-layers, between which there are anastomosing capillaries. The outermost layer consists of peritoneum, the cells of which are very much elongated and compressed. The muscle fibers beneath are mostly transverse and of the non-striated type. The inner layer is epithelial and is also much compressed. The nuclei of the muscle-fibers are long, narrow, rod-like structures which stain deeply, as would be expected, with hæmatoxylin: the nuclei of the epithelium are oval in form. The condition of this ovary does not permit me to go into greater detail.

PLATE II

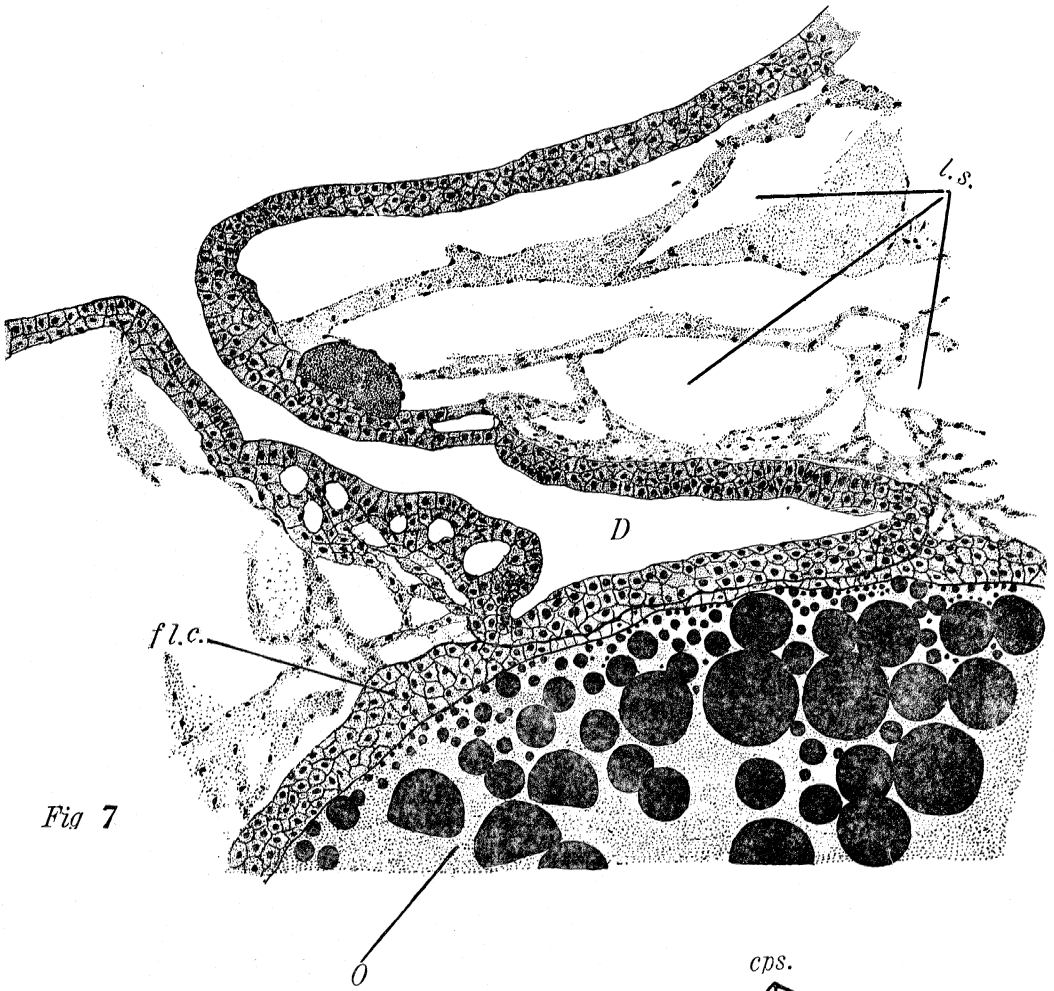

Fig 7

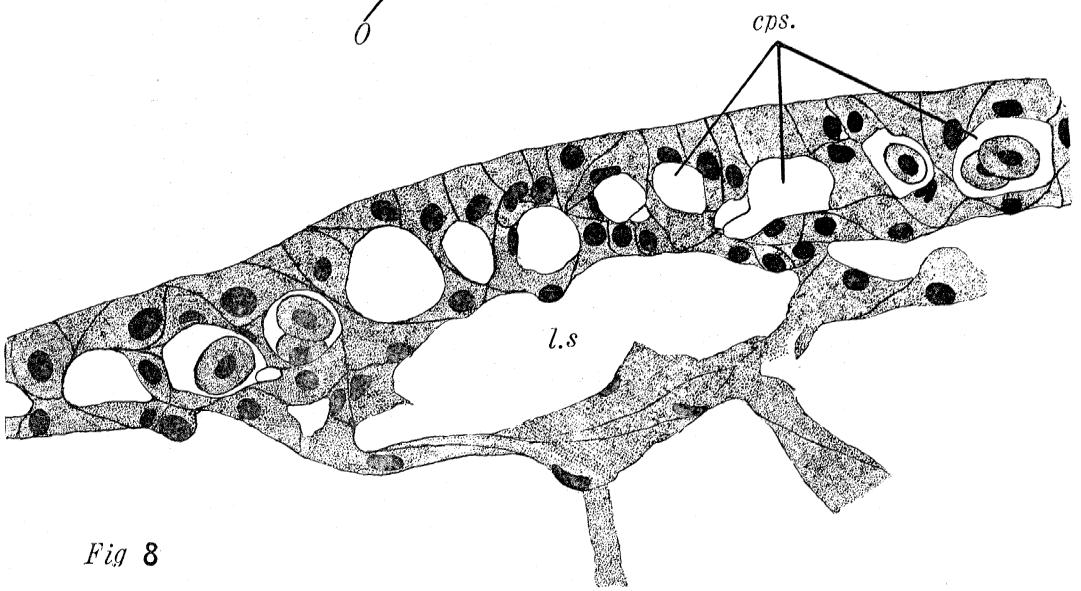

Fig 8

In the ovary of the pregnant female *E*, whose young were almost ready for birth, the ovisac is thinner than in the case just described. The different cell-layers can scarcely be distinguished, though where the cells themselves are visible, the nuclei in section have the rod-like form mentioned above. The capillaries have mostly disappeared, apparently being closed by the crowding together and stretching of the cellular structure ; but in places one comparatively large vessel appears, containing two or more rows of corpuscles, side by side. At this place the wall is enlarged somewhat to accommodate the vessel.

In the ovary of *C*, which contained ova quite well advanced, the ovisac is very similar to that described for *D*. But in some portions of this ovary the muscle layer is restricted almost entirely to longitudinal fibers, the transverse layer being much reduced. Capillaries penetrate freely through these muscle layers in all directions ; those in the lining epithelium are larger than those in the other specimens already described.

In the ovary of *B* the ovisac is similar to that in *C*, but the peritoneal covering is not so distinct ; there is the same arrangement of muscle-fibers — the outer longitudinal and the inner transverse, the latter being much the deeper. The innermost epithelial layer is composed of " pavement " cells with quite large distinct nuclei. Numerous capillaries are found in this inner lining.

Compare in this connection Eigenmann's description of the ovarian wall in *Cymatogaster* (*op. cit.*, p. 418) :

" The ovarian walls are composed, first, of the thin peritoneal membrane ; second, of a layer of longitudinal muscle fibers ; third, of a layer of circular muscle fibers, inside of which there is, in places, a layer of longitudinal fibers ; fourth, of a very thin layer of cells with flattened, deeply stainable nuclei ; fifth, of a layer of epithelium. This layer is derived from the peritoneum."

Stuhlmann found the ovarian wall in *Zoarces* to have a tolerably deep, non-striated, muscle layer, the fibers of which were closely packed together next to the peritoneal covering, but toward the lumen they were split apart by numerous sinuses containing blood vessels. The oviduct was similarly composed, except that there were few if any clefts between the fibers and there were fewer blood vessels.

The unique feature in the ovisac as well as in the epithelial covering of the stroma of *Lucifuga* and *Stygicola* is the presence of capillaries in the lining epithelium (Fig. 8). So far as could be determined this condition has never been observed in the ovary of any other form. So numerous are these capillaries that they attract attention at the first glance. The epithelium itself is often reduced to extreme thinness, sometimes serving merely as a membrane to contain the blood.

VII. The Ovary.

The ovarian structure itself is highly vascular and much lobed. There is a tendency in some instances for these lobes to be arranged in a bilaterally symmetrical pattern, when seen in cross-section, though this is not equally evident in all ovaries or even in all parts of the same ovary. The ovarian structures of the different specimens examined, while presenting numerous points in common, are yet characteristically different in every case.

The ovisac of *A* had but recently contained young, to judge from its extreme thinness; the stroma was so large that it gave promise of containing embryos. Instead of that condition, however, it was found that the large size was due to the mass of stroma which is composed in part of highly vascular tissue. Numerous blood vessels penetrate the stroma in all directions—while around the ova themselves there is a network of capillaries. The greater portion of the stroma is split up into numerous sinuses, many of which are larger than any of its blood vessels. These are closely similar in appearance to the "lymph-spaces" described by Stuhlmann (*op. cit.*, p. 19) for *Zoarces* and no doubt serve the same purpose (Fig. 7, *l.s.*).

The ova of *A* are few in number, less than ten over 60 μ in diameter appearing in any cross-section. Five or six ova are of quite large size, visible even to the naked eye, and measuring from 300 to 800 μ in diameter. They have a large amount, proportionately of yolk-substance. The smaller ova are about 50 to 60 μ in diameter, and are of the usual appearance of ova of that size. The cells of the stroma in this ovary are very irregular in shape, indistinct in outline, and usually of inconsiderable size. The nuclei are round, oval, or elongated, appar-

ently influenced as to form and shape by the cell-body. The entire surface of the stroma is covered by a layer of epithelium, with a depth of 10 to 15 μ. The nuclei of these epithelial cells appear quite distinct, are of a comparatively large size, and are round or oval in shape.

By far the largest amount of space in this epithelial layer is given up to the numerous capillaries contained in it. They are so numerous that, in cross-section, they appear as a row of large perforations, there being no more than a scant cell thickness between them. The average diameter of these capillaries is less than eight micra, in many instances being only five micra. This condition is comparable to that described above for the ovisac and is also unique (Fig. 8).

The ovarian stroma of *E*, which contained the mature fœtuses, has been squeezed and crowded into a median position by the young (Fig. 5). The cellular structure resembles that of the ovary just described, except for such variations as would be caused by its closely packed condition. The capillaries of the epithelial layer, covering its surface, are not so numerous as in the ovary of *A*, but are of larger size. The larger blood vessels are more nearly cylindrical in form and have their walls more thickened than have those in the first ovary. The lymph-spaces in this ovary are compressed by the fœtuses and temporarily eliminated.

Quite different in appearence from either of the two just described, though somewhat intermediate between them in some respects, and more advanced than the first in others, is the ovary of *D*. In this the ovarian stroma has not so many nor such large lymph-sinuses as *A*, but on the contrary has more nearly the appearance of that in *E*, from which it differs conspicuously, however, in not showing a "crowded" appearance, and in having quite numerous ova of various sizes, though none of the latter are so large as those of *A*, and in many cases are grouped together in "nests" in a way largely unknown in *A*. The blood vessels are comparatively numerous, large and quite thick walled. The capillaries in the epithelial covering of the ovary — so conspicuous is that of *A* — are so few in this case as to be visible only when carefully searched for. The cellular structure near and

next to the surface is dense and without important sinuses. The outlines of the cells are very indistinct, but the nuclei are altogether similar to those of the ovaries previously described.

The ovary of *C* approaches more nearly to the condition of *A* than has any of the others; but it differs very characteristically, since in many places it contains "nests" of ova much more conspicuous than any seen in *A*, while the largest ova in this specimen are larger than those in *A*. The ovarian structure itself, while evidently of the same character as that of *A*, does not contain quite so many lymph-spaces, and the walls of the sinuses are somewhat thicker and denser.

The ovary of *B* is almost exactly in the same stage as that of *A*. It differs from *C* in that the egg-nests have given place to single ova of considerable size and greater development than most of those in the latter.

It will be noted that the "nests" of ova are conspicuous in *Lucifuga*, though inconspicuous or lacking in the specimens of *Stygicola* examined. Whether this is a constant distinction can only be determined by the examination of more material than I have in hand.

VIII. Blood Supply to the Ovary.

A small artery, with a diameter, in different ovaries, of 20 to 75 μ, enters each horn of the ovary and runs back near the inner surface of the horn. In the main portion or body of the ovary, the two arteries occupy parallel courses near the center, separated by perhaps one third the diameter of the ovary. Since none of the specimens at hand were injected, the course of these arteries could not be traced except in a general way. But it is plain that they extend posteriorly in a tortuous course through the ovary and give off numerous branches, which find their way to or toward the surface, where they form the capillaries so distinctly visible in some of the ovaries in the epithelial covering. The blood from the epithelial capillaries of the anterior half of the ovary is collected by veinlets, frequently quite large and distinct in the vicinity of the larger ova, which join to form larger veins that pour their contents into the chief vein of the ovary at the "horseshoe bend" (infra). This largest vein has two branches

(one going out by either horn) which are united near the point of division of the ovarian horns, forming a single "horseshoe"-shaped vessel. The veinlets which return the blood from the posterior part of the ovary collect into one vessel which joins the right horn of the "horseshoe" at a considerable distance in front of the fork of the ovary, after running above and parallel to the portion with which it unites, for the distance, in one specimen at least, of nearly 2 mm.

It quite frequently occurs that red-blood corpuscles are present in the ovarian sinuses of *Stygicola* and *Lucifuga*, though their presence may be due to accident. As indicated elsewhere, these sinuses are very probably filled with a plasma or lymph.

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Explanation of Plates.

Fig. 1. External ventral view of the ovary of *Stygicola*. Portions of the peritoneal covering are visible along the sides.

Fig. 2. Cross-section of ovary near the beginning of the oviduct proper. Two large ova at the sides.

Fig. 3. Cross-section of non-pregnant ovary with stroma in two lobes — one dorsal, the other ventral.

Fig. 4. Cross-section of pregnant ovary. The section is made through a region corresponding to that of Fig. 3.

Fig. 5. Cross-section of pregnant ovary through the middle portion. The ovisac collapsed when the fœtuses were removed.

Fig. 6. Cross-section of pregnant ovary through the horns.

Fig. 7. A portion of a cross-section of a non-pregnant ovary, showing a part of a large ovum (*o*) surrounded by its follicle (*fl.c.*); the epithelial covering of the stroma dips down, forming a tube to the ovum (*D*). Bausch and Lomb one sixth objective; 2-in. ocular; tube length, 160 mm.

Fig. 8. Portion of the epithelial covering of a non-pregnant ovary showing the capillaries (*cps.*). Bausch and Lomb one twelfth objective; 1-in. ocular.

a. anterior.
cps. capillaries.
d. dorsal.
D. the "Delle."
fl.c. follicular cells.
l.s. lymph sinus.
mov. mesovarium.
mr. mesorectum.
o. ovum.
ovs. ovisac.
ov.st. ovarian stroma.
p. posterior.
v. ventral.

All drawings by the author; outlines made with Abbé camera; details put in free-hand but with the closest possible regard to accuracy.